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## Fourth Semester B.E. Degree Examination, Jan./Feb. 2023 Complex Analysis, Probability and Statistical Methods

Time: 3 hrs.

Max. Marks: 100

*Note: Answer any FIVE full questions, choosing ONE full question from each module.*

### Module-1

- 1 a. Show that  $f(z) = \sin z$  is analytic and hence find  $f'(z)$ . (06 Marks)
- b. Derive Cauchy Riemann equation in polar form. (07 Marks)
- c. If  $f(z)$  is analytic, prove that  $\left(\frac{\partial}{\partial x}|f(z)|\right)^2 + \left(\frac{\partial}{\partial y}|f(z)|\right)^2 = |f'(z)|^2$ . (07 Marks)

**OR**

- 2 a. Find the analytic function whose imaginary part is  $e^x(x \sin y + y \cos y)$ . (06 Marks)
- b. Show that  $u = \sin x \cosh y + 2 \cos x \sinh y + x^2 - y^2 + 4xy$  is harmonic. Also determine the analytic function  $f(z)$ . (07 Marks)
- c. Derive Cauchy Riemann equation in Cartesian form. (07 Marks)

### Module-2

- 3 a. State and prove Cauchy's integral formula. (06 Marks)
- b. Discuss the transformation  $\omega = z^2$ . (07 Marks)
- c. Find the bilinear transformation which maps the points  $z = \infty, i, 0$  into  $\omega = -1, -i, 1$ . Also find the fixed points of the transformation. (07 Marks)

**OR**

- 4 a. Evaluate  $\int_C |z|^2 dz$  where  $C$  is the square with vertices  $(0, 0), (1, 0), (1, 1), (0, 1)$ . (06 Marks)
- b. Evaluate  $\int_C \frac{e^{2z}}{(z+1)(z-2)}$  where  $C$  is the circle  $|z| = 3$ . (07 Marks)
- c. Find the bilinear transformation which map the points  $Z_1 = i, Z_2 = 1, Z_3 = -1$  onto the points  $\omega_1 = 1, \omega_2 = 0, \omega_3 = \infty$ . (07 Marks)

### Module-3

- 5 a. The probability distribution of a random variable  $X$  is given by the following table:

x	0	1	2	3	4	5	6	7
P(x)	0	K	2K	2K	3K	K <sup>2</sup>	2K <sup>2</sup>	7K <sup>2</sup> +K

- (i) Find  $K$
- (ii) Evaluate  $P(X < 6)$  and  $P(3 < x \leq 6)$  (06 Marks)
- b. The number of telephone lines busy at an instant of time is a binomial variate with probability 0.1 that a line is busy. If 10 lines are chosen at random, what is the probability that, (i) no line is busy (ii) all lines are busy (iii) at least one line is busy (iv) Atmost 2 lines are busy. (07 Marks)

- c. In a certain town the duration of a shower is exponentially distributed with mean 5 minutes. What is the probability that a shower will last for :
- 10 minutes or more
  - Less than 10 minutes.
  - Between 10 and 12 minutes

(07 Marks)

**OR**

- 6 a. The probability density function of a random variable is,

$$P(x) = \begin{cases} Kx^2, & -3 \leq x \leq 3 \\ 0, & \text{Otherwise} \end{cases}$$

Find (i) K (ii)  $P(1 \leq x \leq 2)$  (iii)  $P(x \leq 2)$  (06 Marks)

- b. The probability that a news reader commits no mistake in reading the news is  $\frac{1}{e^3}$ . Find the probability that on a particular news broadcast he commits (i) Only 2 mistakes (ii) more than 3 mistakes (iii) atmost 3 mistakes, assuming that mistakes follow Poisson distribution. (07 Marks)
- c. The marks of 1000 students in an examination follows a normal distribution with mean 70 and standard deviation 5. Find the number of students whose marks will be, (i) less than 65, (ii) more than 75 (iii) between 65 and 75. (Given  $\phi(1) = 0.3413$ ) (07 Marks)

**Module-4**

- 7 a. The ranking of 10 students in two subjects, Field theory (A) and Network Analysis (B) are given below:

Roll No. of the students	1	2	3	4	5	6	7	8	9	10
A	3	5	8	4	7	10	2	1	6	9
B	6	4	9	8	1	2	3	10	5	7

Calculate the Rank correlation coefficient. (06 Marks)

- b. Fit a parabola  $y = a + bx + cx^2$  for the data.

x	0	1	2	3	4
y	1	1.8	1.3	2.5	2.3

(07 Marks)

- c. In a partially destroyed Laboratory record of an analysis. The lines of regression of  $y$  on  $x$  and  $x$  on  $y$  are available as  $4x - 5y + 33 = 0$  and  $20x - 9y - 107 = 0$ . Calculate  $\bar{x}$ ,  $\bar{y}$  and coefficient of correlation between  $x$  and  $y$ . (07 Marks)

**OR**

- 8 a. If  $\theta$  is the angle between the two regression lines, show that

$$\tan \theta = \frac{1-r^2}{r} \cdot \frac{\sigma_x \sigma_y}{\sigma_x^2 + \sigma_y^2} \quad (06 \text{ Marks})$$

- b. Fit a straight line in the least square sense for the following data:

x	50	70	100	120
y	12	15	21	25

(07 Marks)

- c. Find the coefficient of correlation for the data.

x	10	14	18	22	26	30
y	18	12	24	6	30	36

(07 Marks)



**Module-5**

- 9 a. Determine (i) Marginal distribution (ii) Covariance between the discrete random variables X and Y along with the joint probability distribution.

Y \ X	1	3	9
2	$\frac{1}{8}$	$\frac{1}{24}$	$\frac{1}{12}$
4	$\frac{1}{4}$	$\frac{1}{4}$	0
6	$\frac{1}{8}$	$\frac{1}{24}$	$\frac{1}{12}$

(06 Marks)

- b. In 324 throws of a six faced 'die', an odd number turned up 181 times. Is it possible to think that the 'die' is an unbiased one? (07 Marks)
- c. A random sample of 10 boys had the following:  
I.Q : 70, 120, 110, 101, 88, 83, 95, 98, 107, 100  
Does the data support the assumption of a population mean I.Q of 100 at 5% level of significance?  
(Note:  $t_{0.05} = 2.262$  for g d.f) (07 Marks)

**OR**

- 10 a. Explain the terms : (i) Null hypothesis (ii) Confidence intervals (iii) Type I and II errors (06 Marks)
- b. The joint probability of the random variable X and Y as follows :

Y \ X	-4	2	7
1	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{8}$
5	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{8}$

Compute :

- (i)  $E(X)$  and  $E(Y)$   
(ii)  $E(XY)$   
(iii)  $\sigma_x$  and  $\sigma_y$   
(iv)  $COV(X, Y)$  (07 Marks)
- c. Fit a Poisson distribution for the data and test the goodness of fit given that  $\chi_{0.05}^2 = 7.815$  for 3 d.f

x	0	1	2	3	4
f	122	60	15	2	1

(07 Marks)

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## Fourth Semester B.E. Degree Examination, Jan./Feb. 2023 Additional Mathematics – II

Time: 3 hrs.

Max. Marks: 100

**Note: Answer any FIVE full questions, choosing ONE full question from each module.**

### Module-1

- 1 a. Find the rank of the matrix

$$A = \begin{bmatrix} 2 & -1 & -3 & -1 \\ 1 & 2 & 3 & -1 \\ 1 & 0 & 1 & 1 \\ 0 & 1 & 1 & -1 \end{bmatrix} \text{ by applying elementary row transformations.} \quad (06 \text{ Marks})$$

- b. Solve the following system of equations using Gauss elimination method :  
 $x - 2y + 3z = 2$ ,  $3x - y + 4z = 4$  and  $2x + y - 2z = 5$ . (07 Marks)

- c. Find the eigen values of

$$A = \begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix} \text{ and also the corresponding eigen vectors.} \quad (07 \text{ Marks})$$

### OR

- 2 a. Find the rank of the matrix by reducing it to echelon form

$$A = \begin{bmatrix} 1 & 2 & 2 & 4 \\ 2 & 3 & 4 & 6 \\ 3 & 5 & 6 & 10 \\ 4 & -1 & -3 & 2 \end{bmatrix} \quad (06 \text{ Marks})$$

- b. Test for consistency and solve  $5x + 3y + 7z = 4$ ,  $3x + 26y + 2z = 9$ ,  $7x + 2y + 10z = 5$ . (07 Marks)

- c. Solve the following system of equations by Gauss elimination method :  
 $x + 2y + z = 3$ ,  $2x + 3y + 3z = 10$ ,  $3x - y + 2z = 13$ . (07 Marks)

### Module-2

- 3 a. Find the interpolating polynomial for the following values.

x	0	1	2	3
f(x)	1	2	1	10

And hence evaluate  $f(4)$ . (06 Marks)

- b. The Newton- Raphson method to find a real root of the equation  
 $x^3 + x^2 + 3x + 4 = 0$  by performing two iterations. (07 Marks)

- c. Evaluate  $\int_0^1 \frac{x \, dx}{1+x^2}$  by Weddle's rule taking seven ordinates. (07 Marks)



OR

- 4 a. Using Newton's interpolation formula find
- $y(1.4)$
- given

X	1	2	3	4	5
Y	10	26	58	112	194

- (06 Marks)
- b. Find the real root of the equation  $\cos x = 3x - 1$  correct upto three decimal using Regula Falsi method. (07 Marks)
- c. Evaluate  $\int_0^1 \frac{dx}{1+x^2}$  by using Simpson's  $1/3^{\text{rd}}$  rule taking four equal strips. (07 Marks)

Module-3

- 5 a. Solve  $D^3y + 6D^2y + 11Dy + 6y = 0$ . (06 Marks)
- b. Solve  $\frac{d^2y}{dx^2} - 4y = \cosh(2x - 1) + 3^x$  (07 Marks)
- c. Solve  $y'' + 3y' + 2y = 12x^2$  (07 Marks)

OR

- 6 a. Solve  $D^3y - 2D^2y + 4Dy - 8y = 0$ . (06 Marks)
- b. Solve  $y'' + 4y' - 12y = e^{2x} - 3\sin 2x$  (07 Marks)
- c. Solve  $\frac{d^3y}{dx^3} + \frac{d^2y}{dx^2} + 4\frac{dy}{dx} + 4y = x^2 - 4x - 6$ . (07 Marks)

Module-4

- 7 a. Form the PDE by eliminating the arbitrary constants  $z = a \log(x^2 + y^2) + b$ . (06 Marks)
- b. Solve  $\frac{\partial^3 z}{\partial x^2 \partial y} = \cos(2x + 3y)$  (07 Marks)
- c. Solve  $\frac{\partial^2 z}{\partial x^2} + z = 0$ , given that when  $x = 0$ ,  $z = e^y$  and  $\frac{\partial z}{\partial x} = 1$ . (07 Marks)

OR

- 8 a. Form the PDE by eliminating the arbitrary function  $f\left(\frac{xy}{z}, z\right) = 0$ . (06 Marks)
- b. Solve  $\frac{\partial^2 u}{\partial x^2} = x + y$ . (07 Marks)
- c. Solve  $\frac{\partial^2 z}{\partial y^2} = z$ , given the when  $y = 0$ ,  $z = e^x$  and  $\frac{\partial z}{\partial y} = e^{-x}$ . (07 Marks)

**Module-5**

- 9 a. If A and B are any two events of S which are not mutually exclusive then prove that  $P(A \cup B) = P(A) + P(B) - P(A \cap B)$  (06 Marks)
- b. Define conditional probability. Given for the events A and B,  $P(A) = \frac{3}{4}$ ,  $P(B) = \frac{1}{5}$ ,  $P(A \cap B) = \frac{1}{20}$ , find  $P\left(\frac{A}{B}\right)$ ,  $P\left(\frac{B}{A}\right)$ ,  $P\left(\frac{\bar{A}}{\bar{B}}\right)$ ,  $P\left(\frac{\bar{B}}{\bar{A}}\right)$  (07 Marks)
- c. Three machines  $M_1$ ,  $M_2$  and  $M_3$  produce identical items of their respective output 5%, 4% and 3% of items are faulty, on a certain day,  $M_1$  has produced 25% of the total output,  $M_2$  has produced 30% and  $M_3$  the remainder. An item selected at random is found to be faulty. What are the chances that it was produced by  $M_3$ ? (07 Marks)

**OR**

- 10 a. A bag contains 8 white and 6 red balls. Find the probability of drawing two balls of the same colour. (06 Marks)
- b. State and prove Baye's theorem. (07 Marks)
- c. If a pair of dice is thrown what is the probability that
- The sum of numbers is divisible by 4
  - The number on the first is greater than that on the second. (07 Marks)

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# CBCS SCHEME

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18ME42

Fourth Semester B.E. Degree Examination, Jan./Feb. 2023

## Applied Thermodynamics

Time: 3 hrs.

Max. Marks: 100

*Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.*

*2. Use of thermodynamic data handbook is permitted.*

### Module-1

- 1 a. Derive an expression for the efficiency of Otto cycle. (08 Marks)
- b. A 4 cylinder 2 stroke petrol engine has a bore of 57 mm and stroke of 90 mm. Its rated speed is 2800 rpm and is tested at this speed against a brake, which has a torque arm of 0.356 m. The net brake load is 155 N and the fuel consumption is 6.74 lit/hr. The specific gravity of the petrol is 0.735 and it has a calorific value of 44200 kJ/kg. A Morse test is carried out and the cylinders are cut-off in order 1, 2, 3, 4 with corresponding brake torque loads 111, 106.5, 104.2, 111.3 N respectively. Calculate for this speed:
- (i) The engine torque
  - (ii) BMEP
  - (iii) Brake thermal efficiency
  - (iv) BSFC
  - (v) Mechanical efficiency
  - (vi) Indicated thermal efficiency (12 Marks)

OR

- 2 a. Explain knocking in SI engine. What are effects of knocking? (08 Marks)
- b. In an air standard diesel cycle, the compression ratio is 16 and at the beginning of isentropic compression the temperature is 25°C and the pressure is 0.1 MPa. Heat is added until the temperature at the end of constant pressure process is 1500°C. Calculate:
- (i) The cut-off ratio
  - (ii) The heat supplied per kg of air
  - (iii) The cycle efficiency
  - (iv) The mean effective pressure (12 Marks)

### Module-2

- 3 a. Derive an expression for the efficiency of Brayton cycle. (08 Marks)
- b. In a gas turbine installation, the air is taken in at 1 bar and 15°C and compressed to 4 bar. The isentropic efficiency of the turbine and the compressor are 82% and 85% respectively. Determine: (i) Compression work (ii) Turbine work (iii) Thermal efficiency.
- What would be the improvement in the thermal efficiency if a regenerator with 75% effectiveness is incorporated in the cycle? Assume maximum cycle temperature to be 825°K. (12 Marks)

OR

- 4 a. Explain how the regeneration will improve the efficiency of the Brayton cycle. (06 Marks)
- b. With a neat sketch, explain the working of turbojet engine. (04 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8=50, will be treated as malpractice.

- c. In an open cycle gas turbine plant, air enters the compressor at 1 bar and 27°C. The pressure after compression is 4 bar. The isentropic efficiencies of the turbine and compressor are 85% and 80% respectively. Air-fuel ratio is 80:1. Calorific value of the fuel used is 42000 kJ/kg. Mass flow rate of air is 2.5 kg/s. Determine the power output from the plant and the cycle efficiency. Assume that  $C_p$  and  $\gamma$  values are same for both air and products of combustion.

(10 Marks)

**Module-3**

- 5 a. With a schematic and T-S diagram, explain the working of reheat vapour power cycle and deduce an expression for cycle efficiency. (10 Marks)
- b. Steam enters the turbine of a steam power plant, operating on Rankine cycle, at 10 bar, 300°C. The condenser pressure is 0.1 bar. Steam leaving the turbine is 90% dry. Calculate the adiabatic efficiency of the turbine and also the cycle efficiency, neglecting the pump work. (10 Marks)

**OR**

- 6 a. With the help of schematic diagram, T-S diagram explain regenerative vapour power cycle with one open feed water heater and derive an expression for its thermal efficiency. (10 Marks)
- b. An ideal reheat cycle utilizes steam as the working fluid. Steam at 100 bar, 400°C is expanded in the HP turbine to 15 bar. After this it is reheated to 350°C at 15 bar and is then expanded in the LP turbine to the condenser pressure of 0.5 bar. Determine the thermal efficiency and steam rate. (10 Marks)

**Module-4**

- 7 a. With a neat sketch, explain the working of vapour absorption refrigeration system. (10 Marks)
- b. It is required to design an air conditioning plant for an office room with the following conditions:  
 Outdoor conditions: 14°C DBT and 10°C WBT  
 Required conditions: 20°C DBT and 60% RH  
 Amount of air circulated 0.3 m<sup>3</sup>/min/person  
 Seating capacity of the office = 60  
 The required condition is achieved first by heating and then by adiabatic humidifying. Determine the following:  
 (i) Heating capacity of the coil in KW and the surface temperature required if the bypass factor of the coil is 0.4.  
 (ii) Capacity of the humidifier. (10 Marks)

**OR**

- 8 a. With the help of schematic diagram and appropriate psychrometric diagram, explain summer air conditioning system for hot and dry outdoor conditions. (10 Marks)
- b. A Freon-12 refrigerator producing a cooling effect of 20 kJ/s operates on a simple cycle with pressure limits of 1.509 bar and 9.607 bar. The vapour leaves the evaporator dry saturated and there is no under cooling. Determine the power required by the machine. If the compressor operates at 300 rpm and has a clearance volume of 3% of stroke volume, determine the piston displacement of the compressor. For compressor assume that the expansion following the law  $PV^{1.3} = \text{constant}$ . Given:

Temperature °C	P in bar	$V_g$ in m <sup>3</sup> /kg	Enthalpy kJ/kg		Entropy kJ/kg/K		Specific heat kJ/kg/K
			$h_f$	$h_g$	$s_f$	$s_g$	
-20	1.509	0.1088	17.8	176.61	0.073	0.7082	-
40	9.607	-	74.53	203.05	0.2716	0.682	0.747

(10 Marks)



**Module-5**

- 9 a. Derive the condition for minimum work in a 2 stage reciprocating air compressor. Using this condition obtain the expression for minimum work in a two stage compression. (10 Marks)
- b. A single cylinder, single acting reciprocating air compressor is belt driven from an electric motor at 300 rpm. The cylinder diameter is 20 cm and the stroke is 24 cm. The air is compressed from one atmosphere to 8 atmosphere and the law of compression is  $PV^{1.25} = \text{constant}$ . Find the power of the electric motor if the transmission efficiency is 96% and the mechanical efficiency of the compressor is 85%. Neglect clearance effect. (10 Marks)

**OR**

- 10 a. Explain different types of steam nozzles. (06 Marks)
- b. Starting from steady flow energy equation, derive an expression for velocity of steam coming out of nozzle. (06 Marks)
- c. An adiabatic steam nozzle is to be designed for a discharge rate of 10 kg/s of steam from 10 bar and 400°C to a back pressure of 1 bar. The nozzle efficiency is 0.92 and the frictional loss is assumed to take place in the divergent portion of the nozzle only. Calculate:
- (i) Velocity of steam at throat and exit of the nozzle
- (ii) Throat and exit area
- Assume index of expansion = 1.3. (08 Marks)

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# CBCS SCHEME

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18ME43

## Fourth Semester B.E. Degree Examination, Jan./Feb. 2023 Fluid Mechanics

Time: 3 hrs.

Max. Marks: 100

- Note:** 1. Answer any FIVE full questions, choosing ONE full question from each module.  
2. Any missing data assumed suitably.

### Module-1

- 1 a. Define the following terms with SI units:  
(i) Mass density (ii) Kinematic viscosity  
(iii) Capillarity (iv) Compressibility (10 Marks)
- b. An oil film thickness 1.5 mm is used for lubrication between a square plate of size  $0.9 \text{ m} \times 0.9 \text{ m}$  slides down as a inclined plane having an inclination of  $20^\circ$  with horizontal. The weight of the square plate is 392.4 N and it slides down the plane with a uniform velocity of 0.2 m/s. Find the kinematic viscosity of oil. Specific gravity of oil is 0.7. (10 Marks)

OR

- 2 a. State and prove Pascal's law. (06 Marks)
- b. Derive an expression for total pressure torque and depth of centre of pressure for an inclined plane surface submerged in liquid. (06 Marks)
- c. A simple U-tube manometer containing mercury is connected to a pipe in which a fluid of specific gravity 0.8 and having vacuum pressure is flowing. The other end of manometer is open to atmosphere. Find the vacuum pressure in a pipe, if the difference of mercury level in two limbs is 40 cms and height of the fluid in the left from the centre of pipe is 15 cm below. (08 Marks)

### Module-2

- 3 a. Define the following terms:  
(i) Buoyancy  
(ii) Centre of buoyancy  
(iii) Meta centric height  
(iv) Meta centre (08 Marks)
- b. Explain different types of fluid flow. (04 Marks)
- c. Derive continuity equations in Cartesian coordinated for a fluid flow 3 dimensional steady incompressible flow. (08 Marks)

OR

- 4 a. Write an expression for acceleration of fluid in x, y and z directions. Differentiate between local and convective acceleration. (06 Marks)
- b. The velocity potential function ( $\phi$ ) is given by the expression  $\phi = -2 \ln(x^2 + y^2)$ . Show that it represents a possible case of fluid flow. (06 Marks)
- c. A solid cylinder of diameter 4 m has a height of 3m. Find the meta centre height when it is floating with its axis vertical. The specific gravity of cylinder is 0.6. (08 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.



**Module-3**

- 5 a. With a suitable assumption, derive a Bernoulli's equation. (07 Marks)
- b. A pipe line is carrying an oil of specific gravity 0.87, the diameter of pipe changes from 200 mm at section A to 500 mm at section 'B' which is 4 m higher than A. If the pressure at 'A' and 'B' is 100 kPa and 60 kPa respectively and if the discharge is 200 kg/s. Determine:  
(i) Loss of head (ii) Flow direction. (06 Marks)
- c. Obtain the Euler's equation of motion along a stream line. State the assumptions made. (07 Marks)

**OR**

- 6 a. Derive Hagen Poiseuille equation for laminar flow through a circular pipe. (06 Marks)
- b. Three pipes of length 800 m, 500 m and 400 m of diameters 500 mm, 400 mm and 300 mm respectively are connected in series, these pipes are replaced by a single pipe of 1700 m. Find the diameter of the single pipe. (10 Marks)
- c. Write a note on venture-meter. (04 Marks)

**Module-4**

- 7 a. Explain boundary layer separation and discuss methods of controlling boundary layer separation. (10 Marks)
- b. What is a similitude's? Explain the following:  
(i) Geometric similarity  
(ii) Dynamic similarity (10 Marks)

**OR**

- 8 a. The frictional torque of a disc of diameter 'D' depends on speed 'N' in a fluid dynamic viscosity  $\mu$  and density of fluid  $\rho$  in a turbulent fluid flow by Buckingham's PI method develop a frictional torque T. (10 Marks)
- b. The resisting force 'F' of a plane during flight can be considered as dependent upon length of aircraft 'l' velocity V, air viscosity  $\mu$ , air density  $\rho$  and bulk modulus of air K. Express the functional relationship between these variable and the resisting force using dimensional analysis. Explain the physical meaning of these groups. (10 Marks)

**Module-5**

- 9 a. Define stagnation properties. Obtain an expression for stagnation pressure of a compressible fluid in terms of Mach number and pressure. (08 Marks)
- b. A projectile travels in air of pressure 15 N/cm<sup>2</sup> at 10°C at a speed of 1500 km/hr. Find the Mach number and Mach angle. Take  $\gamma = 1.4$  and  $R = 287$  J/kgK. (08 Marks)
- c. What is normal shock and oblique shocks? (04 Marks)

**OR**

- 10 a. Define the following terms:  
(i) Mach number  
(ii) Zone of action  
(iii) Subsonic flow  
(iv) Supersonic flow  
(v) Transonic flow (10 Marks)
- b. Explain CFD and mention its applications. (06 Marks)
- c. Explain one dimensional flow. (04 Marks)

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# CBCS SCHEME

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18ME44

Fourth Semester B.E. Degree Examination, Jan./Feb. 2023

## Kinematics of Machines

Time: 3 hrs.

Max. Marks: 100

*Note: Answer any FIVE full questions, choosing ONE full question from each module.*

### Module-1

- 1 a. Define the following :  
(i) Link (ii) Kinematic chain (iii) Degree of freedom (iv) Inversion (06 Marks)  
b. Explain Grubler's criterion for plane mechanism. (06 Marks)  
c. What are quick return motion mechanisms? When are they used? Sketch and explain the functioning of Whitworth mechanism. (08 Marks)

OR

- 2 a. Derive an expression for necessary condition of correct steering and explain Ackerman steering gear with neat sketch. (10 Marks)  
b. Sketch and explain following mechanisms:  
(i) Drag link mechanism (ii) Geneva wheel. (10 Marks)

### Module-2

- 3 a. State and prove Kennedy's theorem. (06 Marks)  
b. In a reciprocating engine the length of crank is 250mm and length of connecting rod is 1000mm. The crank rotates at an uniform speed of 300 rpm in clockwise direction and the crank is inclined at  $30^\circ$  with inner dead centre. The centre of gravity of connecting rod is 400mm from the crank end. By Klein's construction determine  
(i) Velocity and acceleration of piston.  
(ii) Angular velocity and acceleration of connecting rod.  
(iii) Velocity and acceleration at the centre of gravity of connecting rod. (14 Marks)

OR

- 4 In a four bar mechanism ABCD, AD is fixed link of 120 mm long. The crank AB is 30mm and rotates at 100 rpm clockwise while CD = 60mm oscillates about D. BC and AD are of same length. Find the angular velocity of link CD when angle BAD =  $60^\circ$  by  
(i) relative velocity method (ii) Instantaneous centre method. (20 Marks)

### Module-3

- 5 Using complex algebra derive expressions for velocity and acceleration of the piston angular acceleration of connecting rod of a slider crank mechanism. (20 Marks)

OR

- 6 a. Derive Freudenstein's equation for slider crank mechanism. (10 Marks)  
b. Design a four link mechanism to coordinate three positions of the input and the output as follows:

$$\begin{array}{ll} \theta_1 = 20^\circ & \phi_1 = 35^\circ \\ \theta_2 = 35^\circ & \phi_2 = 45^\circ \\ \theta_3 = 50^\circ & \phi_3 = 60^\circ \end{array}$$

(10 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and/or equations written eg. 4+8=50, will be treated as malpractice.



**Module-4**

- 7 A cam rotates at a uniform speed of 300 rpm clockwise and gives an oscillating follower 75mm long, an angular displacement of  $30^\circ$  in each stroke. The follower is fitted with a roller of 20mm diameter which makes contact with the cam. The outward and inward displacements of the follower each occupying  $120^\circ$  cam rotation and there is no dwell in the lifted position. The follower moves throughout with SHM. The axis of fulcrum is 80mm from the axis of cam and least distance of roller axis from cam axis is 40mm. (20 Marks)

**OR**

- 8 A vertical spindle supplied with a plane horizontal face at its lower end is actuated by a cam keyed to a uniformly rotating shaft. The spindle is raised through a distance of 30mm in one fourth, remains at rest in one fourth, is lowered in one third and remains at rest for the remainder of a complete revolution. Draw the profile assuming the least radius of cam profile as 25mm and that the spindle moves with uniform acceleration and retardation on both ascent and descent, however during descent deceleration period is half the acceleration period. The axis of the spindle passes through cam axis. The cam rotates in anticlockwise direction. (20 Marks)

**Module-5**

- 9 a. Derive an expression for minimum number of teeth necessary for gear to avoid interference. (10 Marks)  
 b. The standard full depth  $14\frac{1}{2}^\circ$  gear have module of 5mm. The pinion has 15 teeth and the gear has 60 teeth. Addendum = 1 module.  
 (i) Show that the gear will interfere with pinion  
 (ii) Should the pressure angle be increased to eliminate the interference? (10 Marks)

**OR**

- 10 a. Explain the term train value and velocity ratio used in gear train. (04 Marks)  
 b. In an epicyclic gear train the internal wheels A, B and the compound wheel C and D rotate independently about the axis 'O'. The wheels E and F rotate on a pin fixed to the arm G. E gears with A and C, and F gears with B and D. All the wheels have same pitch and the number of teeth on E and F are 18; C = 28, D = 26.  
 (i) Sketch the arrangement  
 (ii) Find the number of teeth on A and B  
 (iii) If the arm G makes 150 rpm CW and A is fixed find the speed of B.  
 (iv) If the arm G makes 150 rpm CW and wheel A makes 15 rpm CCW find the speed of B. (16 Marks)

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# CBCS SCHEME

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18ME46B/18MEB406

## Fourth Semester B.E. Degree Examination, Jan./Feb. 2023 Mechanical Measurements and Metrology

Time: 3 hrs.

Max. Marks: 100

*Note: Answer any FIVE full questions, choosing ONE full question from each module.*

### Module-1

- 1 a. Define metrology. State the objectives of metrology. (06 Marks)  
b. Distinguish between line standard and end standard. (06 Marks)  
c. Four length of bars A, B, C, D of approximately 250 mm each are to be calibrated with standard calibrated metre bar which is actually 0.0008 mm less than a metre. It is also found that, bar B is 0.0002 mm longer than bar A, bar C is 0.0004 mm longer than bar A and bar D is 0.0001 mm shorter than bar A. The length of all four bars put together is 0.0003 mm longer than the calibrated standard metre. Determine the actual dimension of each bar. (08 Marks)

OR

- 2 a. Explain the wringing phenomena of slip gauge. (05 Marks)  
b. Explain the working of autocollimator with the help of a neat sketch. (07 Marks)  
c. Select size of the angle gauges required to build the following angles. Also sketch the arrangement: (i)  $33^{\circ}16'42''$  (ii)  $102^{\circ}8'42''$  (08 Marks)

### Module-2

- 3 a. With a general sketch, explain the limits, tolerance, fits, allowances and deviations. (10 Marks)  
b. What is meant by interchangeability? State its advantages. (06 Marks)  
c. Enumerate the classification of plain gauges. (04 Marks)

OR

- 4 a. Define comparator. What is the need of comparator? (04 Marks)  
b. With a neat sketch, explain the working of sigma comparator. (08 Marks)  
c. Sketch and explain the working of LVDT. (08 Marks)

### Module-3

- 5 a. Derive the expression for the effective diameter of screw thread using two wire method. (10 Marks)  
b. With a neat sketch, explain the construction and working of tool makers microscope. What are its applications? (10 Marks)

OR

- 6 a. Explain how gear tooth Vernier caliper is used to measure gear tooth thickness. (10 Marks)  
b. With a schematic diagram, explain the working principle of CMM. (10 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and /or equations written eg,  $42+8=50$ , will be treated as malpractice.

**Module-4**

- 7 a. Explain the generalized measurement system with the aid of block diagram. (10 Marks)  
b. Explain the following terms:  
(i) Sensitivity (ii) Repeatability (iii) Linearity  
(iv) Threshold (v) Least count (10 Marks)

**OR**

- 8 a. What is transducer? Sketch and explain working principle of piezo-electric transducers. (10 Marks)  
b. With a neat sketch, explain the working of CRT. (10 Marks)

**Module-5**

- 9 a. With a neat sketch, explain the working of Rope brake dynamometer. (10 Marks)  
b. With a neat sketch explain the working of McLeod gauge. (10 Marks)

**OR**

- 10 a. What is thermocouple? State the laws of thermocouple. (08 Marks)  
b. Describe the working and construction of optical pyrometer. (08 Marks)  
c. Write short note on gauge factor. (04 Marks)

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